

106370

FM 5-10

# ENGINEER FIELD MANUAL

## COMMUNICATIONS, CONSTRUCTION, AND UTILITIES

Prepared under direction of the  
Chief of Engineers



UNITED STATES  
GOVERNMENT PRINTING OFFICE  
WASHINGTON: 1940

For sale by the Superintendent of Documents, Washington, D. C. - Price \$1.00

WAR DEPARTMENT,  
WASHINGTON, September 9, 1940.

FM 5-10, Engineer Field Manual, Communications, Construction, and Utilities, is published for the information and guidance of all concerned.

[A. G. 062.11 (4-30-40).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,  
Chief of Staff.

OFFICIAL:

E. S. ADAMS,  
Major General,  
The Adjutant General.

II

## TABLE OF CONTENTS

	Paragraphs	Page
CHAPTER 1. ROADS.		
Section I. General.....	1-12	1
II. Reconnaissance.....	13-14	9
III. Construction.....	15-21	15
IV. Maintenance and repairs.....	22-24	26
V. Construction, maintenance, and repair of various road types.....	25-38	32
VI. Plant and equipment.....	39-44	57
VII. Summary.....	45	67
CHAPTER 2. BRIDGING, GENERAL.		
Section I. Bridging considerations.....	46-51	68
II. Design of bridges.....	52-69	75
III. Reconnaissances and investigations.....	70-80	110
IV. Summary.....	81	139
CHAPTER 3. STANDARD MILITARY BRIDGES.		
Section I. General.....	82-84	140
II. Floating bridges.....	85-94	142
III. Trestle bridges.....	95-99	175
IV. Steel trusses.....	100-101	181
V. Improvised methods.....	102-104	186
VI. Summary.....	105	193
CHAPTER 4. MEANS OF CROSSING STREAMS OTHER THAN BY BRIDGES.		
Section I. Passage by fords.....	106-109	194
II. Passage on ice and by swimming.....	110-112	198
III. Passage by boats, rafts, and ferries.....	113-117	200
CHAPTER 5. MILITARY RAILWAYS.		
Section I. General.....	118-126	213
II. Railway reconnaissance.....	127-134	223
III. Location and construction.....	135-159	230
IV. Maintenance of way.....	160-169	265
V. Rolling stock.....	170-171	269
VI. Methods of car loading.....	172-174	280
VII. Summary.....	175	282
CHAPTER 6. CONSTRUCTION IN WAR.		
Section I. General.....	176-180	283
II. Troop facilities.....	181-194	288
III. Supply facilities.....	195-196	319
IV. Air corps facilities.....	197-200	323
V. Summary.....	201	326
CHAPTER 7. WATER SUPPLY.		
Section I. General.....	202-203	328
II. Reconnaissance.....	204-210	336
III. Development of sources.....	211-215	344
IV. Purification.....	216-223	350
V. Pipe distribution.....	224-226	358
VI. Requirements and equipment.....	227-228	362
VII. Summary.....	229	364

III

CHAPTER 8. ELECTRICITY.	Paragraphs	Page
Section I. General.....	230-234	366
II. Military requirements.....	235-238	368
III. Reconnaissance.....	239-242	369
CHAPTER 9. RIGGING.....	243-250	380
CHAPTER 10. CONCRETE AND QUARRY OPERATIONS.		
Section I. Concrete.....	251-263	401
II. Quarry operations.....	264-265	421
INDEX.....		425

FM 5-10

## ENGINEER FIELD MANUAL

### COMMUNICATIONS, CONSTRUCTION, AND UTILITIES

(The matter contained herein supersedes part one (tentative), Engineer Field Manual, volume II, June 16, 1932; part three (tentative), Engineer Field Manual, volume II, June 20, 1932; TR 185-5, July 31, 1924 (including C1, January 3, 1928); TR 445-215, January 24, 1925; and TR 1445-206, June 30, 1926.)

#### CHAPTER 1

##### ROADS

	Paragraphs
SECTION I. General.....	1-12
II. Reconnaissance.....	13-14
III. Construction.....	15-21
IV. Maintenance and repairs.....	22-24
V. Construction, maintenance, and repair of various road types.....	25-38
VI. Plant and equipment.....	39-44
VII. Summary.....	45

#### SECTION I

##### GENERAL

■ 1. GENERAL.—The planning and construction of military roads require maximum attention and adherence to the fundamentals of simplicity, sound organization, and economy of time, materials, transportation, and force. Maximum use must be made of the existing road net by effecting necessary repairs thereto in order to hold new construction at a minimum. Care is necessary also to insure against the attempted maintenance of too many roads, the result of which may be a complete break-down of the supply system so necessary to the well-being and success of an army. On the other hand, it is essential that an adequate road net be provided and maintained at all times, particularly between supply establishments, for the rate of movement and existence of an army is dependent upon the rate at which it can receive supplies, and this, in turn, depends upon the sufficiency of the road system and the rate at which it can be advanced. The heavy

or towed by a rope around the waist. It may also be floated across on plank floats when these are available.

(4) If desired, ropes may be stretched across the stream to assist in the crossing. This may be accomplished by having good swimmers carry across a small rope to which is tied the larger rope to be used. The rope to be used is stretched tight and tied to tree trunks or strong stakes on opposite banks so that it hangs at about the surface of the water. Floats may be used to keep it at this height. It may be used to assist in the crossing of those who cannot swim, to aid the poorer swimmers, or to serve as a life line in swift currents.

*c. Floats and individual rafts.*—A plank, approximately 3 inches by 10 inches by 10 feet, will serve to support a fully equipped soldier. Smaller planks will serve as an aid. The soldier after removing his equipment, wrapping it in a bundle, and tying it on his back, can lie flat on a plank and paddle across a stream of moderate current and width. Over greater distances such a method of crossing is very laborious and is likely to be unsuccessful.

### SECTION III

#### PASSAGE BY BOATS, RAFTS, AND FERRIES

■ 113. **GENERAL.**—Usually the crossing of the initial waves of the covering forces will be by means of boats, as only in rare cases can the passage be made by fords, swimming, or on ice. If boats are locally available in any quantity, they may be used for this purpose. Normally, however, the standard assault boat will be used, supplemented by ponton boats or rafts. A brief description of the assault boat and the technique of its use is given herewith.

■ 114. **ASSAULT BOAT.**—*a. Description.*—The assault boat is of a conventional skiff type, with a flat bottom, a square, slightly sloping stern, and a pointed bow; it weighs about 200 pounds (fig. 67). The skin is of  $\frac{1}{4}$ -inch fir plywood, highly resistant to the effects of moisture. Seven paddles of the ordinary canoe type are provided with each boat for propelling it when fully loaded.

*b. Capacity.*—With 6 inches of freeboard in the stern and 12 inches at the bow, the displacement of the boat is approximately 3,200 pounds. It will safely carry (with the men fully equipped) any of the following loads:

- (1) Eleven men.
- (2) Ten men, one .30 caliber machine gun and its tripod, and 13 boxes of ammunition.
- (3) Ten men, one .50 caliber machine gun and its tripod, and 4 boxes of ammunition.
- (4) Nine men, the 37-mm gun (old model) on its wheels, and 4 boxes of ammunition.
- (5) Nine men, the 81-mm mortar, and 50 rounds of ammunition.
- (6) Nine men and the equipment of the advanced echelon of the infantry battalion communication section.

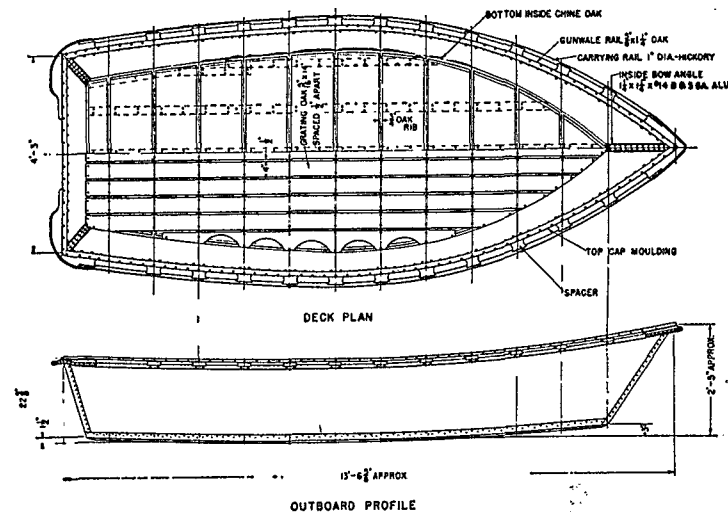


FIGURE 67.—Plan and side elevation of assault boat.

If a crew is used, these capacities are reduced by the number of men provided for this purpose. The available space, rather than safe buoyancy, limits the capacity in each case.

*c. Transportation by truck.*—Ten boats are nested for transport as a standard load for the  $1\frac{1}{2}$ -ton truck (fig. 68). When more than 10 are carried the load becomes too high, top-

heavy, and unwieldy; also there is danger of damage to the lower boats in the pile. On trucks with narrow bodies when the load of the nested boats would be carried on the hand-rails of the bottom boat, wide timber blocks should be provided on the floor of the truck. This blocking will raise the bottom boat so its gunwales are above the sides of the truck.

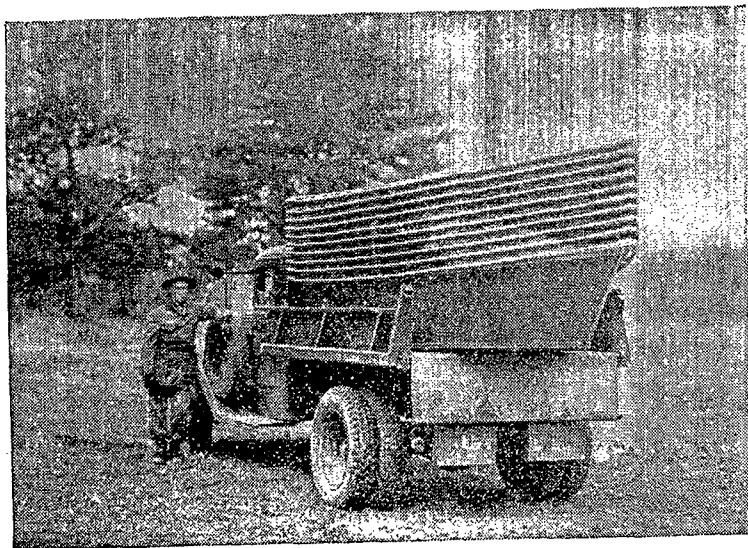


FIGURE 68.—Engineer 1½-ton dump truck with normal load of 10 assault boats.

*d. Storage and care.*—When not in use, the boats should be kept under cover; before being placed in storage they should be cleaned, dried out, and painted if necessary. The boat has so few seams, well protected by metal strips, that only rarely will there be any necessity for soaking it before putting it into the water after a long period of dry storage. The boats should be handled with considerable care; they are designed and constructed so as to be as light as possible, and hence are less durable and more fragile than heavier types. Major repairs to the skin should be made with moistureproof plywood. Ordinary standard olive-drab oil paint is suitable for these boats. Patches may be made of thin metal sheets and nails, preferably of copper. Bullet holes

may be plugged temporarily with wads of cloth or paper, pegs, adhesive tape, putty, and chewing gum.

*e. Function.*—The primary function of the assault boat is to furnish a rapid means of crossing streams for the troops and weapons of the initial combat waves in the attack of river lines. Assault boats are normally continued in use as a crossing means (supplementing other forms of equipment) until adequate bridging facilities have been put into operation or until the need for them no longer exists. Two engineers are usually provided as a crew to act as guides and return the boat for each new trip. The engineer personnel is charged with the proper use and operation of the boats while they are being carried to the bank and when crossing the water.

*f. Final assembly area.*—The final assembly area is the area designated in orders where engineer troops, assault boats, and Infantry meet and from which the assault boats are carried to the river by the Infantry. The assault boats are moved to this area, unloaded, and disposed for ease in carrying to the river. Some desirable characteristics of the final assembly area for a crossing force are:

- (1) Ease of access for vehicle or hand transport bringing up the assault boats.
- (2) Defilade (protection from artillery and rifle fire).
- (3) Concealment from ground and aerial observation.
- (4) Numerous foot routes to river easily followed by carrying parties.
- (5) Proximity to crossing fronts.
- (6) Width enough for foot routes spaced widely apart over entire crossing front.

*g. Movement to the river.*—The following general considerations should be observed:

- (1) The passengers and crew comprising the first wave carry the assault boat from the final assembly area to the near bank on the crossing front and launch it in the water. Not more than ten men (fig. 69) should carry the boat and at least four should be used even for a short carry.
- (2) From the time it leaves the final assembly area until it reaches the far bank, an assault boat should not stop its

missible speeds. Its consumption of gasoline will run to only about 50 gallons per hour, and no water or maintenance facilities are required in excess of those essential for heavy trucks.

Figure 94 illustrates the comparative sizes and appearance of the steam and light locomotives.

*c. Commercial rolling stock.*—Locomotives are classed according to the number of forward truck wheels, drivers, and rear truck wheels, considered in that order. Thus an engine with 2 forward truck wheels, 4 drivers, and 2 rear truck wheels is indicated by the designation, 2-4-2. Other types are similarly designated. The cars include coaches, sleepers, box cars, tank cars, stock cars, flat cars, gondolas, cabooses, and special cars such as refrigerators, wrecking cars, hospital cars, and kitchen cars. For data as to dimensions and capacities see tables XLII and XLIII.

TABLE XLII.—Dimensions and capacities, typical standard-gage rolling stock

Class	Dimensions				Capacity				
	Length inside measurement (feet)	Width (feet)	Height (feet)	Approximate weight (empty in tons)	Tons	Cubic feet, approximate	Floor space, (square feet)	Animals	Men (allowing about 8 square feet per man and equipment)
Box.....	34	8	7	15	30	1,900	272	19	34
	36	8	8	20	40	2,300	288	20	36
	40.5	8.5	8	23	50	2,750	344	22	43
Flat.....	38	9	---	17	40	---	342	---	---
	40	9.2	---	20	50	---	370	---	---
	42	9.5	---	25	70	---	399	---	---
Stock.....	36	8.5	7.6	14	30	2,300	306	20	---
	36	8.5	8	18	40	2,450	306	20	---
Gondola.....	34	8.5	2.6	20	40	720	289	---	---
	40.5	8.8	2.6	25	50	890	354	---	---
	46	9.5	3	30	70	1,310	437	---	---
Automobile.....	36	8.5	8	20	40	2,450	306	20	38
	40.5	8.8	9	24	50	3,250	364	22	45
Tank.....	35	6.5	---	20	40	8,000 gals.	---	---	---
	33.5	7.2	---	25	50	10,000 gals.	---	---	---
Refrigerator.....	30	8	7	16	30	1,680	240	(1)	(1)
	33	8.3	7.6	21	40	2,060	275	(2)	(2)
Baggage.....	60	9	---	50	---	---	540	---	---
Caboose.....	31.5	8.5	6.8	20	---	---	---	---	---
Diner.....	80.5	---	---	80	---	---	---	---	---
					Passenger capacity				
					2 per double seat	3 per 2 double seats	3 per section		
Coach.....	63	---	---	60	70	46	---	---	---
Sleeper, 12 sections and drawing room.....	74	---	---	70	---	---	40	---	---
Sleeper, 16 sections.....	74	---	---	70	---	---	48	---	---

<sup>1</sup> Ice capacity, 4 tons.

<sup>2</sup> Ice capacity, 5 tons.

## SECTION VII

## SUMMARY

■ 175. SUMMARY.—*a.* Railways are superior to any other form of land transportation for bulk movements of supplies and troops over distances greater than about 75 miles.

*b.* Advantage is to be taken of existing lines, and no attempt will be made to procure permanence in new construction.

*c.* Roadbed and track will be as light as is consistent with the objects to be attained.

*d.* The efficient moving of freight requires full use of car capacities, prompt handling, and adequate storage facilities.

*e.* Inadequate terminal facilities limit the capacity of a railway as a whole.

*f.* Full use will be made of available commercial rolling stock.

*g.* Car loading is largely a matter of expediency, aided by the application of ingenuity and common sense.

*h.* General engineer troops must be prepared to construct, reconstruct, maintain, and repair short lengths of line.

*i.* In maintaining a railway line, first attention should be given to bridges, tunnels, terminals, and similar vulnerable points.

*j.* Continual reconnaissance is vital to the maintenance of a railway.

## CHAPTER 6

## CONSTRUCTION IN WAR

	Paragraphs
SECTION I. General .....	176-180
II. Troop facilities .....	181-194
III. Supply facilities .....	195-196
IV. Air Corps facilities .....	197-200
V. Summary .....	201

## SECTION I

## GENERAL

■ 176. GENERAL.—*a. Simplicity.*—All construction in the theater of operations is of the simplest nature. Only common construction materials and supplies should be used.

*b. Economy of materials.*—Economy of materials is obtained by—

(1) Limiting all construction to temporary, emergency facilities, providing only the barest necessities.

(2) Maximum use of existing structures and local materials.

(3) Use of type plans.

*c. Type plans.*—Type plans, such as those illustrated in this manual permit efficient utilization of personnel, materials, and available time. Detailed type plans are prepared in peacetime by the Corps of Engineers. They are the basis for the procurement of standardized materials to be shipped to the theater of operations.

*d. Provision for expansion.*—Projects should be laid out so that future expansion is feasible if any possible need for expansion can be foreseen. So far as practicable the project should be planned in its entirety and a suitable site chosen. Only units actually needed are constructed initially. They are practically completed before beginning additional work, even though an uneconomical working schedule results. The object is to obtain complete units for early use and to avoid work on units which later changes in plan may cause to be abandoned.

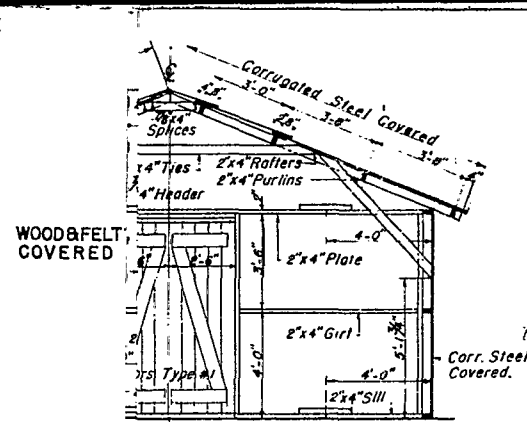
c. *Active defenses.*—Active defense is provided by anti-aircraft weapons and by friendly aviation.

## SECTION II

### TROOP FACILITIES

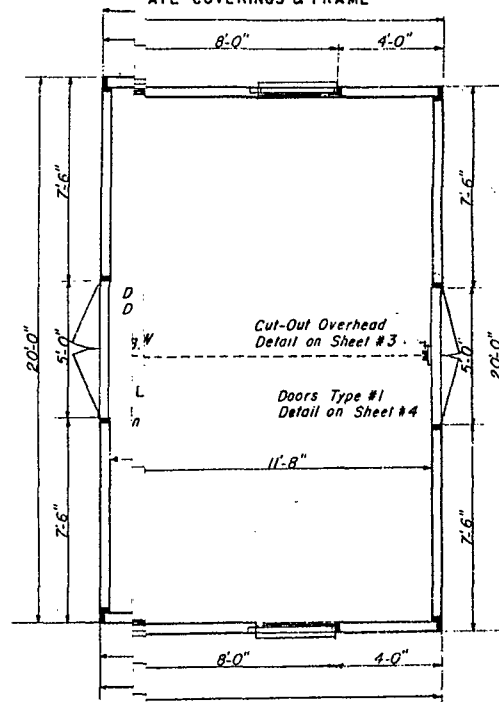
■ 181. **STANDARD BUILDING.**—*a. Discussion.*—Figure 96 shows the standard 20- by 100-foot building. This building is designed for a variety of uses, such as barracks, warehouses, mess halls, administration buildings, infirmaries, hospital wards, etc. It is essentially a lightweight frame, sheathed with wood or corrugated steel. Standard sizes of lumber are used. Bracing is limited to essentials; the stability of the structure depends partly upon the stiffness of the complete assembly of sides and ends. Corrugated steel is the simplest covering, but should not be used in hospitals because it is hot in summer and cold in winter. Common batten doors (fig. 97) are used, with any simple available hardware. They may be single or double, covered with either corrugated steel or wood. Screen doors as shown in figure 98 are used only on hospital wards, kitchens, and mess halls. The window frame (fig. 99), assembled in the field, is either screened or covered with a translucent material. Glass is not used. Ventilators (fig. 100), when required, may be either the ridge type or the tubular metal type. Floors are used only when absolutely necessary. Figure 101 shows two types of floors. The type A floor is installed on level and the type B floor on uneven ground. Use of the latter should be avoided, as it is more costly.

*b. Bill of materials.*—A bill of materials for the standard building is given in table XLVII, below:

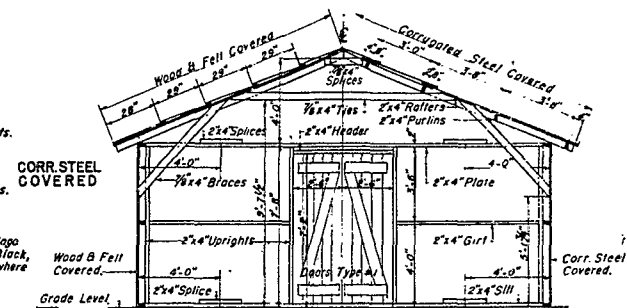
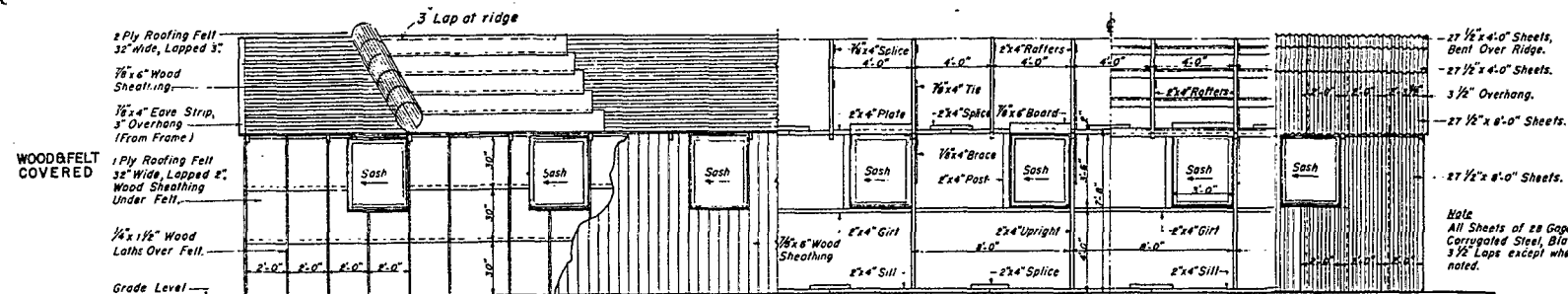


### ION A-A

ATE COVERINGS & FRAME





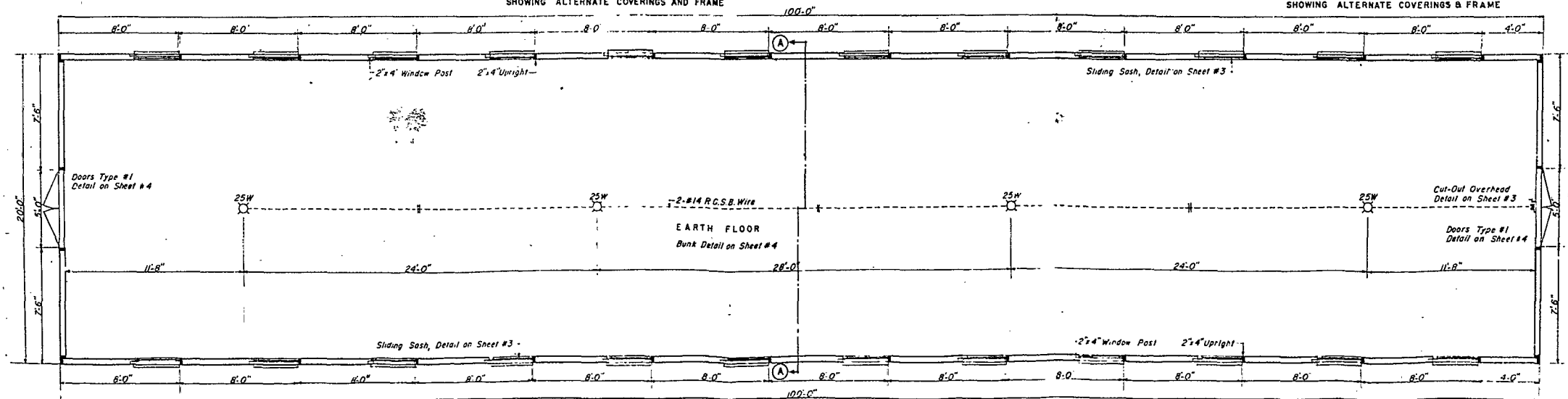


FRONT ELEVATION

SHOWING ALTERNATE COVERINGS AND FRAME

SECTION A-A

SHOWING ALTERNATE COVERINGS & FRAME



FLOOR PLAN

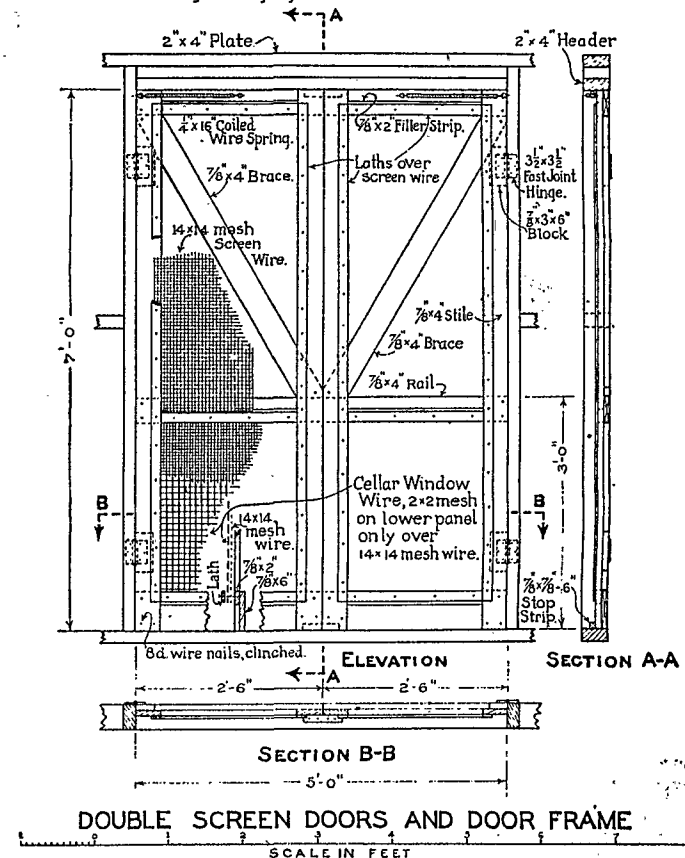
FIGURE 96.—Standard building, 20 by 100 feet.

DETAIL OF DOOR & FRAME

PIECES FOR PAIR OF DOORS TYPE I (TWO PAIR REQUIRED)						
DESCRIPTION	MARKED	NO. PC.	SIZE	LGTH	APPLICATION	
LUMBER	D1	8	$\frac{3}{4}$ " x 6"	7'-2"		
"	D2	2	$\frac{1}{2}$ " x 6"	7'-2"		
"	D3	2	$\frac{1}{4}$ " x 6"	5'-8"		
"	D4	4	$\frac{1}{2}$ " x 6"	2'-4"		
"	D5	1	$\frac{1}{4}$ " x 3"	7'-2"		
"	L1	5	$\frac{1}{8}$ " x 2"	8"		
"	L2	2	$\frac{1}{8}$ " x 2"	3"		
"	L3	1	$\frac{1}{4}$ " x 3"	10"		
"	L4	1	$\frac{1}{4}$ " x 8"	10"		
NAILS		40	6d	2"	D4 to D1 & D2	
"		30	6d	2"	D3 to D1 & D2	
"		15	5d	1 1/2"	D5 to D2	
"		8	6d	2"	L1 to D2	
"		4	6d	2"	L2 to D2	
"		12	6d	2"	L1 to L1 & L2	
"		1	6d	2"	L3 to L4	
HINGES		4	T	10"		
SCREWS		16		1"		

FIGURE 97.—Batten door, type 1.

NOTE - All screen doors trimmed  $\frac{1}{4}$ " smaller in length and width for easy swinging in door frame.



DOUBLE SCREEN DOORS AND DOOR FRAME

BILL OF MATERIAL			Items
No.	Size	Length, Ft. & In.	
4	7/8" x 1/2"	14'-0"	Stiles, Top and Middle Rails, Diagonal Braces and Hinge Blocks.
2	7/8" x 7/8"	14'-0"	Stop Strips " Filler Strips for Screen Wire.
1	7/8" x 6"	6'-0"	Bottom Rails.
4	3/8" x 3/4"		Rail Joint Hinges.
2	3"		Screw Hooks and Eyes.
2	1/2" x 3"	16'	Coiled wire spring.
1	2 1/2" x 14'-0"		Screen Wire, 14 x 14 Mesh.
1	2 1/2" x 6'-0"		Cedar Window Wire, 2 x 2 Mesh.
1/4 lb.	5 d.		Nails for Strips and Blocks.
1/2 "	8 d.		Nails " Framing.
1/2 "	3 d.		Staples for Cedar Window Wire - Double Pointed.
1/2 "	No. 3		Tacks for Screen Wire.
1/2 "	No. 16 W.	3/4"	Nails for Laths.
14	7/4" x 1 1/2"	4'-0"	Laths.

Above bill for 1 pair of screen doors Labor equals 6 Man Hours.	Note - Add 5% to items in bill and man hours labor for contingencies.
--	--

FIGURE 98.—Screen door.

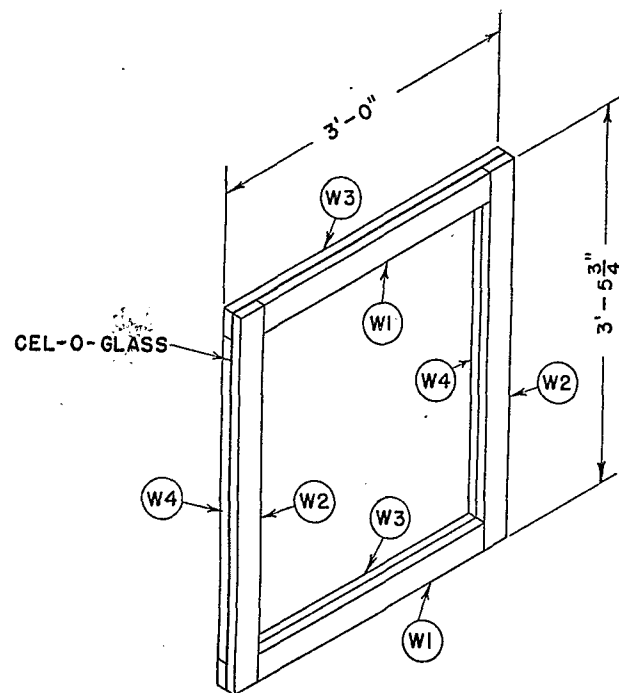
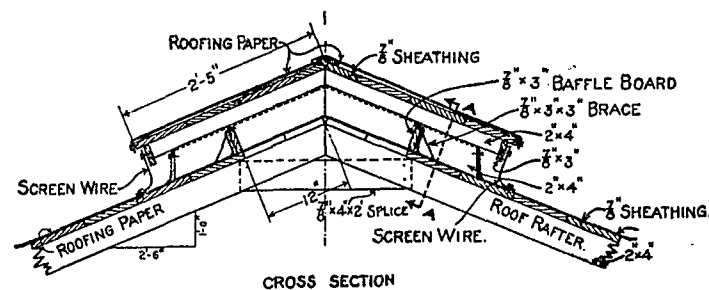


DIAGRAM OF SASH

PIECES FOR ONE SASH					
(24 REQUIRED)					
DESCRIPTION	MARKED	NO. PC.	SIZE	L'GTH.	APPLICATION
LUMBER	W1	2	7/8 x 3"	2'-6"	
"	W2	2	7/8 x 3"	3'-5 3/4"	
"	W3	2	7/8 x 3"	3'-0"	
"	W4	2	7/8 x 3"	2'-11 3/4"	
NAILS		4	4d	1 1/2"	W1 TO W3
"		4	4d	1 1/2"	W3 TO W1
"		12	4d	1 1/2"	W2 TO W4
"		8	4d	1 1/2"	W4 TO W2
CORNER NAILS		4	4d	1 1/2"	W1 TO W2
"	"	4	4d	1 1/2"	W3 TO W4
CEL-O-GLASS			36"	41 3/4"	BETWEEN W2 & W4

FIGURE 99.—Details of window sash.



CROSS SECTION

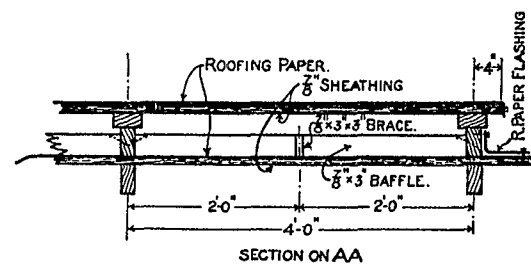


FIGURE 100.—Ridge ventilator.

■ 182. LAYOUT OF SEMIPERMANENT CAMPS.—*a. Requirements.*—Structural requirements for semipermanent camps for units for various arms will depend upon the current Tables of Organization. Facilities needed in every semipermanent camp are barracks, messes, latrines, baths, lavatories, administration building, medical building, guardhouses, storehouses, post exchange, officers' mess, and officers' quarters. Units having motors require shops; units having animals require stables, corrals, and watering troughs. One recreation building per regiment or independent battalion is conducive to good morale. Tents may be used in place of barracks. Local facilities, especially roads, should be used to avoid unnecessary construction. Kitchens, hospitals, warehouses, stables, motor parks, and offices should be accessible by roads. Stables, incinerators, and latrines should be located where prevailing winds will carry annoying odors away from the camp. Latrines should be located as far away from kitchens as practicable to lessen the fly nuisance. A compact layout is preferable, but provision should be made for future possible expansion. Water-bearing fire preventive systems are too expensive to be used; chemical carts are practicable. Figure 102 shows a typical semipermanent camp layout for a triangular infantry division.

*b. Rule of thumb.*—A rough rule for determining the area of a semipermanent camp for any unit is as follows:

50 square yards per man.

60 square yards per animal.

150 square yards per vehicle.

To use the rule, multiply each unit figure by the corresponding number of men, animals, and vehicles in the unit, and add the products. Application of this rule to Tables of Organization gives the data tabulated below. To this total must be added the area needed for general supply, training, station hospital, railroad yards, etc. The figures also apply approximately to tent camps where space is available for erection without crowding.

TABLE XLVIII.—Approximate areas required for semipermanent barrack camps for the square infantry division, peace and war strength

Unit	Area (acres)	
	Peace strength	War strength
Division headquarters and special troops.....	10.5	15
Infantry brigade headquarters and headquarters company.....	1	1
Infantry regiment.....	23	31
Infantry brigade.....	47	65
Headquarters and headquarters battery, field artillery brigade.....	1.5	1.5
Field artillery regiment (75-mm gun, horse-drawn).....	32	33
Field artillery regiment (75-mm gun, truck-drawn).....	20	21
Field artillery regiment (155-mm howitzer).....	26	27
Field artillery brigade.....	80	83
Engineer combat regiment.....	11.5	12.5
Medical regiment.....	8.5	15
Quartermaster regiment.....	16	25
Total for a division (exclusive of division aviation and landing field).....	175	216

TABLE XLIX.—Approximate areas required for semipermanent barrack camps for the triangular infantry division, peace strength

Unit	Area (acres) peace strength
Division headquarters.....	1.5
Headquarters and military police company.....	3
Signal company.....	4
Engineer battalion.....	5
Medical battalion.....	4
Quartermaster battalion.....	7
Field artillery regiment (75-mm gun).....	26
Field artillery regiment (155-mm howitzer).....	15
Infantry regiment, each (3).....	24
Total for a division.....	138

TABLE L.—Approximate areas required for semipermanent barrack camps for certain units of the cavalry division, peace and war strength

Unit	Area (acres)	
	Peace strength	War strength
Cavalry regiment, horse.....	20	44
Engineer squadron.....	6.5	6.5
Field artillery regiment (75-mm field howitzer, horse).....	34	35

■ 183. BARRACKS.—In the theater of operations, a fair assumption is that barracks will have to be provided for 60 percent of the total force plus 100 percent of the prisoners. In any particular camp, barracks must be provided for all of the troops, and may have to be provided for civilian labor. Barrack space is provided on a basis of 50 men per standard building, 20 by 100 feet. An air space of 400 cubic feet per man is required as a minimum. One hundred men per standard building, 20 by 100 feet, can be sheltered in emergencies, but this is undesirable from a health standpoint. Bunks, of the double-decker type where space is scarce, should be provided for all men. Figure 103 shows a bunk for two men.

Figures 104 and 105 show tent frames for various types of tents suitable for personnel shelters.

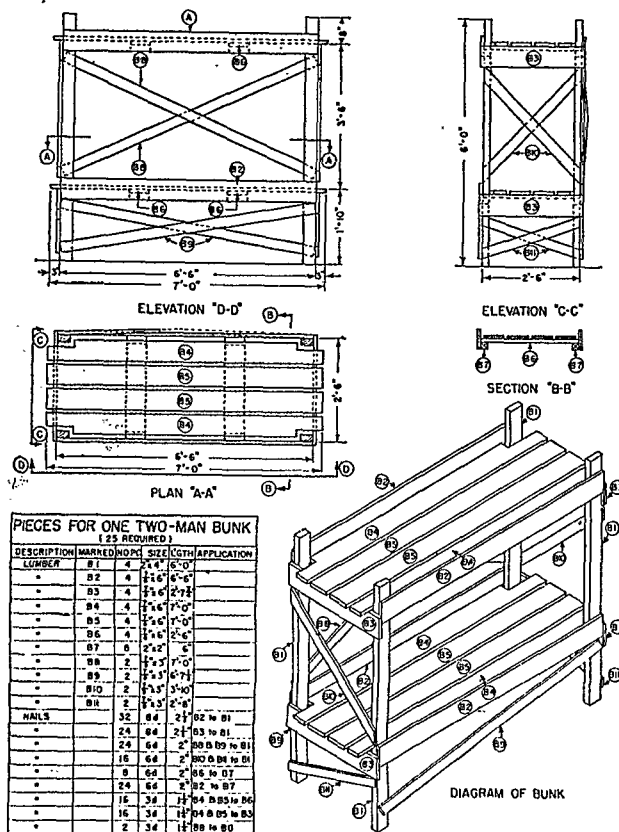
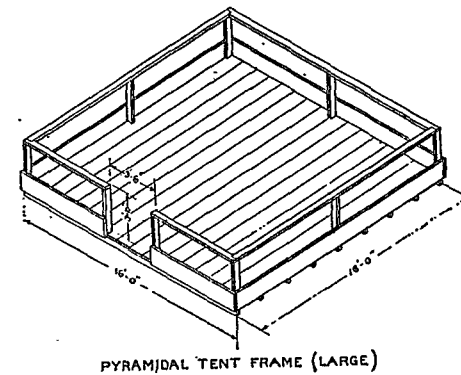
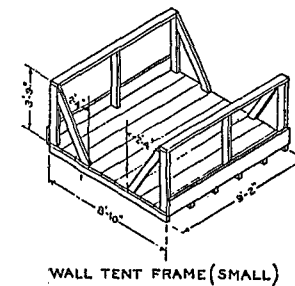


FIGURE 103.—Bunk for two men.



BILL					ITEMS
No	Qty	Size	QTY	FRM	
5	2 x 4	16'-0"	86		Floor Sleepers
5	2 x 6	256			Floor Boards 5 1/2" & 2 1/2" Lumber
3	10				Nails for Floor
4	2 x 4	16'-0"	43		Roiling
3	2 x 4	10'-0"	20		Posts
4	1 x 12	16'-0"	64		Skirt Boards
3	10	20 d			Nails for Framing
1	10	10 d			

LABOR: 24 MAN HRS.



BILL					ITEMS
No	Qty	Size	QTY	FRM	
6	2 x 4	10'-0"	40		Floor Sleepers
6	2 x 6	81			Floor Boards 5 1/2" & 2 1/2" Lumber
2	10	4 d	24		Nails for Floor
2	2 x 4	10'-0"	13		Roiling
2	12		16		Posts
2	10		13		Braces
2	10		13		Skirt Boards
2	10	20 d			Nails for Framing
1	10	10 d			

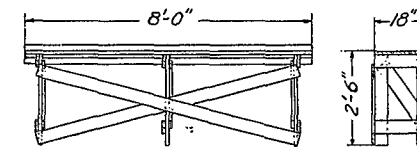
LABOR: 10 MAN HRS.

FIGURE 104.—Pyramidal and small wall tent frames.

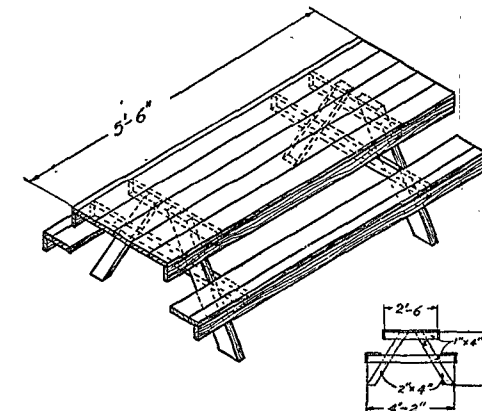


■ 184. OFFICERS' QUARTERS.—The standard building is adapted for officers' quarters by partitioning off double rooms 8 by 16 feet. A messroom and kitchen may be installed at one end, as shown in figure 106.

■ 185. KITCHEN AND MESS HALLS.—Figure 107 shows the standard building adapted for use as a mess hall suitable for 120 men. A space 20 by 12 feet at one end suffices for the



SERVING TABLE



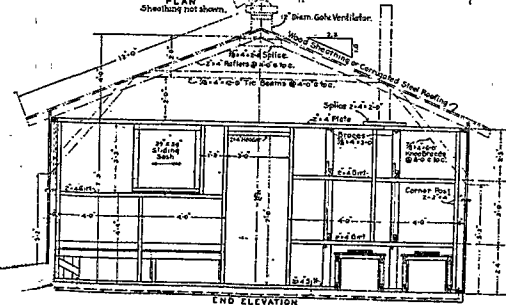
MESS TABLE

FIGURE 108.—Mess hall accessories.

kitchen. Two buildings 20 by 100 feet can be combined to give a mess hall suitable for 240 men.

Figure 108 shows a mess table combined with seats, and a serving table.





306

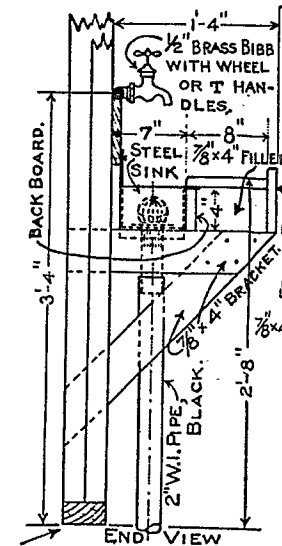
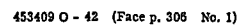
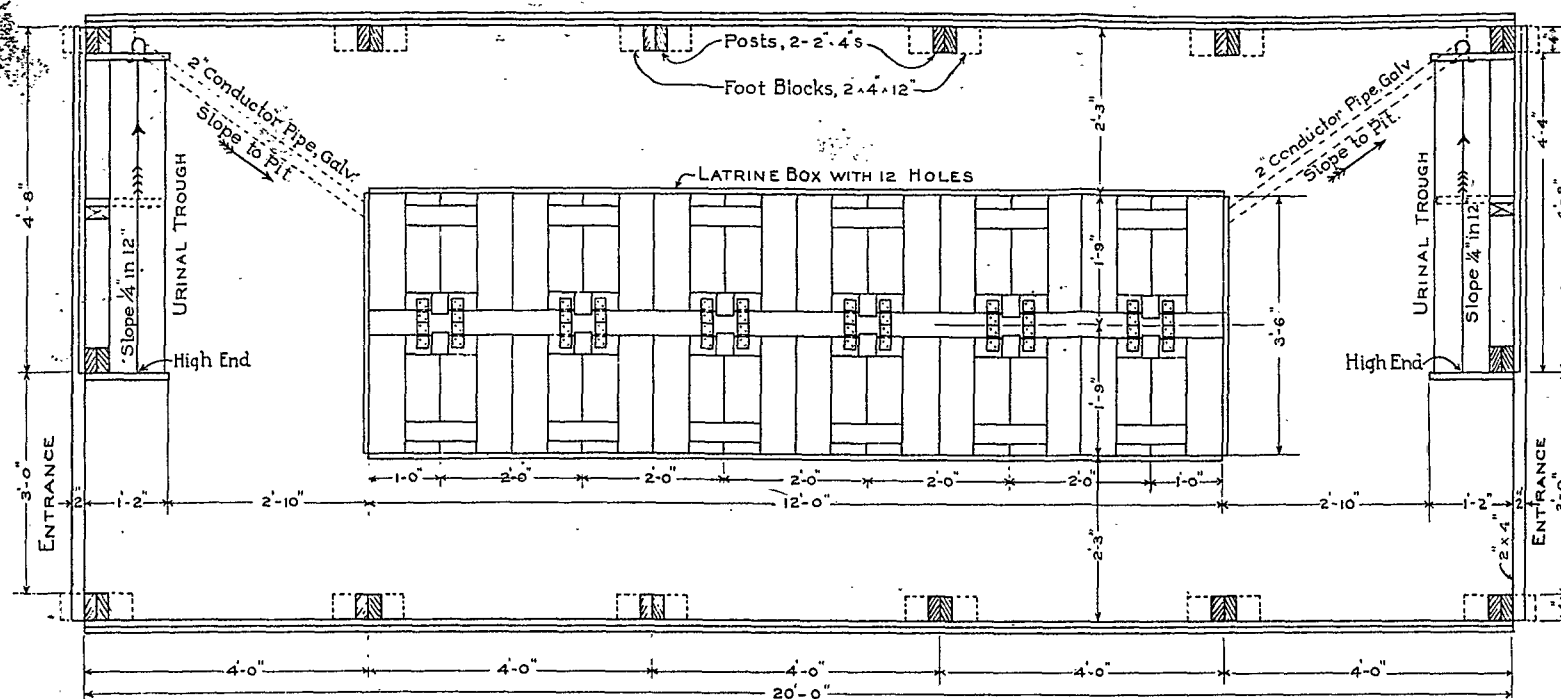


FIGURE 110.—Lavatory with benches.

MATERIAL FOR LAVATORY				ITEMS.
No.Pcs.	SIZE	LENGTH	FT.BM.	
27	2"x4"	16'	288	SILLS, GIRTS, PLATES, STUDS, FURLINS.
		SUB-SILLS		PUR, BRACES, SPLICES, & FLR. JOISTS.
16	2"x4"	12'	128	RAFTERS, BENCH LEGS, PIPE SUP. & FL. JOI. SPLS.
35	2"x8"	12'	280	FLOOR BDS, ABLUTION BENCH TOP & SASH CORNERS
4	2"x6"	14'	28	DOOR, BOARD.
20	7/8"x6"	8'	80	ABL. & SCRUB. BENCHES & BDS. OVER WINDOW
13	7/8"x4"	8'	35	ABL. & SCRUB. BEN. & ABL. BEN. BRACKETS
5	7/8"x4"	12'	20	RAFTER TIES & KNEE BRACES.
4	7/8"x3"	12'	12	SILLS & SASHES, WINDOW.
1	7/8"x1 1/2"	10'	1 1/2	WINDOW FILLS.
2	7/8"x1"	14'	10	STRIPS FOR DOOR & WINDOWS.
8		10"		T HINGES WITH SCREWS-STEEL.
2		3"		SCREW HOOKS & EYES.
12	26" W.	8'	BLACK	CORR. STEEL SHEETS *26GA. FOR ROOF.
12	"	6'	"	" " " " " " " "
27	"	8'	"	" " " " " " SIDES & END
	24" W.	8'		STEEL SHEETS, GALV. *26 GAUGE.
3	36" W.	8'		" " " " " " " "
1/2 lb.	3/16"	3/4"		RIVETS FOR CORR. STEEL SHEETS.
2 lbs	#10	1 1/2"		NAILS, BARBED, FOR ROOFING.
12 lbs	20 &	4"		" FOR FRAMING WORK.
10 lbs	8 &	2 1/2"		" FOR 7/8" STUFF.
1 lb.	4 &	1 1/2"		" FOR WINDOW STRIPS & DOORS.
4	3/4"	12 TO 16		W. I. PIPE, GALV. FOR SUPPLY.
2	1"	" "		" " " " " " " "
1	1 1/2"	" "		" " " " " " " "
	2"	40 LIN. FT.		" " " " " " BLACK " WASTE.
4	3/4"			ELBOWS, FOR SUPPLY, GALV.
2	1 3/4"			" " " " " " " "
1	1 1/2"			" " " " " " " "
1	2"	45'		" " " " " " WASTE.
4	3/4"x2			CROSSES.
18	3/4"x2			TEES.
2	1"x1"			" " " " " " " "
4	2"			" " " " " " " "
	3/4"			CAP.
2 EACH	2 3/4"			PLUGS.
1 EACH	1 3/4"			UNIONS.
	1 1/2 TO 1"			REDUCER.
12	1"			PIPE STRAPS, TINNED.
1	1 1/2"			STOP & WASTE COCK-LEVER HANDLE.
36	1/2"			COMPRESSION BIBBS, ROUGH BRASS.
4	2"	6"		THIMBLE, COMPLETE WITH WIRE STRAINER
1 LB.				ROOFING CEMENT FOR THIMBLES.



SECTIONAL PLAN

NOTE - Omit Prepared Roofing if Cover Strips are used.

No Pcs	Size	Length	Ft BM	ITEMS
34	2"x4"	8'-0"	161	Studs, U. & L. End Girts & Foot Blocks.
6	2"x4"	10'-0"	40	Roof Rafters.
8	2"x4"	12'-0"	64	Plates & Lower Girts on Sides.
20	7/8"x6"	16'-0"	160	Sheathing on Sides.
49	7/8"x6"	10'-0"	245	Sheathing on Roof, & Ends.
6	7/8"x4"	12'-0"	24	Purlins.
40	7/8"x3"	10'-0"	100	Strips for covering Roof joints if used.
3 Pkts	32 W	4"		2 Ply Prepared Roofing, Nails, Caps, Cem.
6 lbs	20 d	3"		Nails for Framing.
8 lbs	10 d	3"		Nails for Framing.
12 lbs	8 d	2 1/2"		Nails for Sheathing.

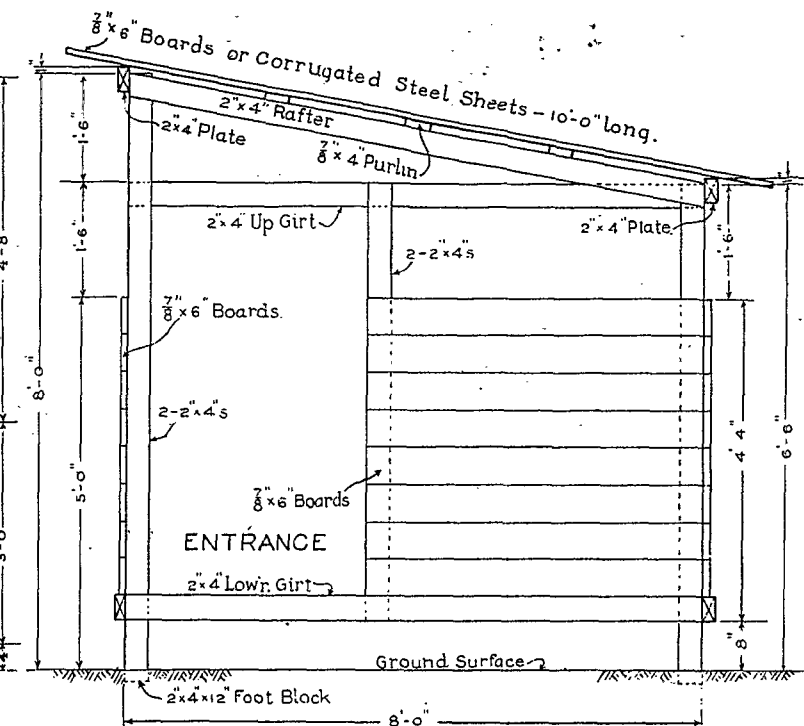
LABOR on Shelter (wood roof) incl. 2 Urinal Troughs = 24 MAN HRS.

No Pcs	Size	Length	Ft BM	ITEMS
4	2"x4"	12'-0"	32	Frame
6	7/8"x8"	8'-0"	32	Cover, Top only.
4	7/8"x6"	12'-0"	24	Lids and Two End Boards.
10	7/8"x4"	10'-0"	33	End Boards, Sides & Fillers.
3	7/8"x3"	8'-0"	6	Lid Batten and Stop Blocks.
1 lb.	20 d	4"		Nails for Framing.
1/2 lb.	10 d	3"		Nails for Framing.
1 Roll	32 W	2 1/2"		Nails for Sheathing.
24	2 W	3 1/8"		Tar Paper for Fly-proofing, Nails, Caps, etc.

LABOR = 22 MAN HOURS

No Pcs	Size	Length	Ft BM	ITEMS
1	2"x4"	6'-0"	4	Bracket Support
1	7/8"x8"	6'-0"	4	End Boards
3	7/8"x6"	10'-0"	15	Trough and Splash Boards
1	7/8"x4"	6'-0"	2	Bracket
1 Roll	32 W	40 1/2"		Tar Paper, Heavy, incl Nails, Cement & Caps
1/2 lb.	10 d	3"		Nails
1 lb.	8 d	2 1/2"		Nails
2	2"	2'-6"		Elbows for Conductor Pipe, Galv.
2	2"	2'-6"		Conductor Pipe, Galv.
2	2"	4'-0"		Conductor Pipe, Galv.

LABOR = 3 MAN HOURS



END ELEVATION

Entrances to be screened with burlap or brush screens, when necessary.

No Pcs	Size	Length	Ft BM	ITEMS
1	27 1/2" W x 10' L	10'-0"	1 1/2	Corrugated Steel Sheets, No 28 Ga.
1/2 lb.	5/8" dia	1 1/2"		Nails Barbed Roofing.
				Lead Washers.

No Pcs	Size	Length	Ft BM	ITEMS
14	2"x4"	10'-0"	93	Studs
1	4'-0"	30'-0"		Canvas for Screening or Burlap.

LABOR = 5 MAN HOURS

FIGURE III. - Latrine.

■ 186. BATHHOUSES.—A minimum of one bathhouse per battalion area should be provided. This small allowance requires careful administration and supervision in the use of the bathhouses. One bathhouse per company, troop, or battery should be provided wherever possible. Figure 109 shows a company bathhouse and lavatory, 20 by 24 feet, constructed in a manner similar to the standard building.

■ 187. LAVATORIES.—Lavatories with ablution and scrubbing benches, as shown in figure 110, are installed at the rate of one per company whenever possible. The number of facilities depends on the water available.

■ 188. LATRINES.—Water-bearing sewerage seldom will be used. Simple latrines placed over pits generally will be provided. About one seat to 20 men is desirable, but one seat to 40 men will suffice. Figure 111 shows a standard 12-seat latrine, in a building 20 by 8 feet. If necessary, the shelter may be replaced with a simple burlap screen. Where water-bearing sewerage is installed, a simple septic tank may be constructed underground. This consists of a tank served by inlet and outlet pipes, with baffles to slow the flow. The ratio of length to width should be about 4:1, and the depth from 5 to 10 feet. Concrete is a satisfactory material. Organic matter is largely dissolved by bacterial action, and the tank requires cleaning only once or twice a year. The velocity of flow should be under 1 foot per minute. The tank capacity should be about 2 days of sewage.

For officers' and nurses' quarters a pail latrine may be used, consisting of a latrine box with removable pails underneath instead of the pit.

■ 189. SHEDS.—*a. Storage and repair shelters.*—Figure 112 shows an open-sided storage shed suitable for use where supplies are placed under the roof by hand. The roof must be raised by use of longer posts to permit vehicles to be driven underneath. This type of shed is suitable for vehicle repair work and storage of spare parts. All vehicles are stored outside. In this connection, vehicle storage areas should be graded to provide drainage. Roadways serving repair and storage areas should be surfaced, but not the storage areas themselves.

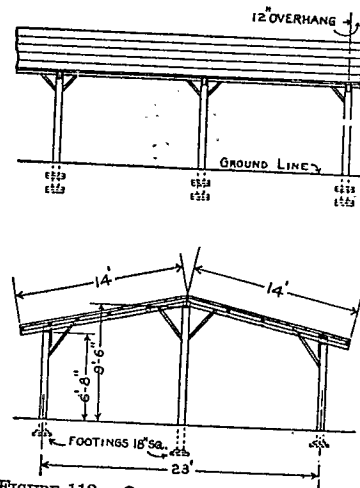


FIGURE 112.—Open-sided storage shed.

*b. Animal shelters.*—With mangers and feed racks installed, the open-sided storage shed makes a satisfactory horse shelter. The sides may be sheathed if necessary. Figure 113 shows this type of building, including a center grain-storage room, feed racks, mangers, and covered picket line.

■ 190. LAYOUT OF HOSPITALS.—*a. Percentage allowances.*—Total hospitalization requirements ordinarily vary between 5 and 15 percent of the total strength of the troops in the theater of operations. Prolonged fighting and unhealthful conditions may combine to necessitate total hospital provision for considerably more than 15 percent. Station hospitals at semipermanent camps should provide for hospitalization of about 5 percent of the troops in the area. The remainder of the requirement is provided in general hospitals.

*b. Space.*—Hospital space allowances necessarily exceed those in barracks. A minimum space at each bed of 60 square feet per patient is required. An additional minimum allowance of 30 to 35 square feet per patient should be provided for administration, supply, operating rooms, and accom-

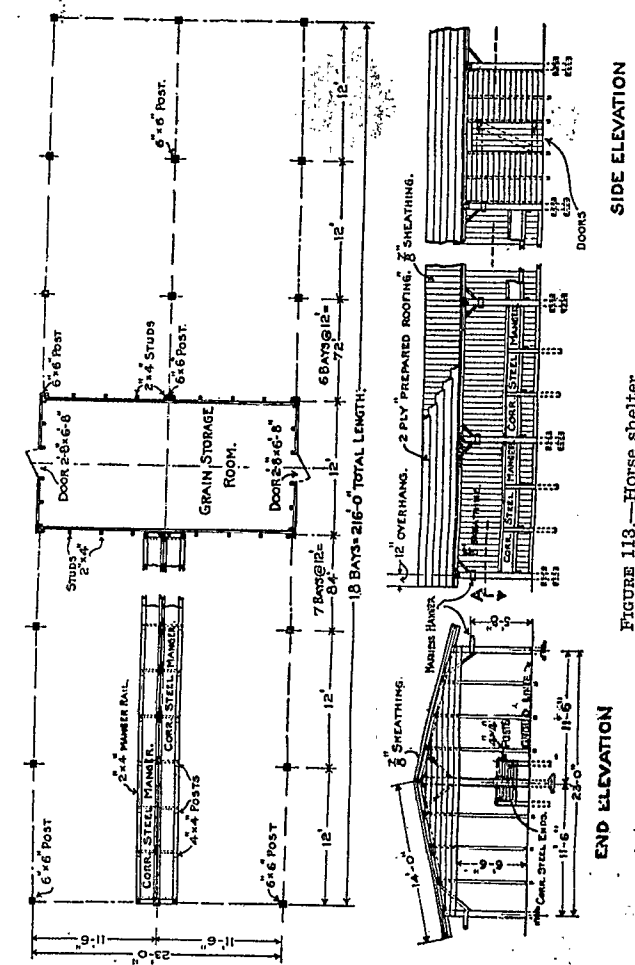


FIGURE 113.—Horse shelter.

modation of hospital personnel. General hospitals are constructed in 1,000-bed units; in emergency their capacity can be increased to 1,200 beds. Station hospitals are constructed in 250-bed units. Figure 114 shows a typical layout for a 250-bed station hospital.

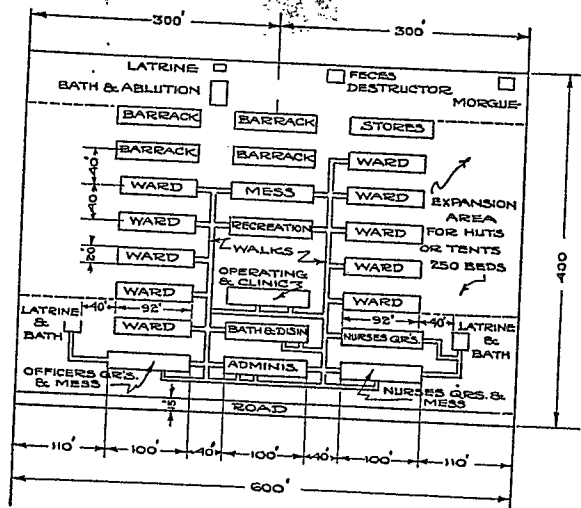


Figure 114.—Typical layout for 250-bed station hospital. Individual wards are constructed for normal capacities of 25 and 50 patients. Figure 115 shows the two types of wards. Table LI gives a corresponding bill of materials.

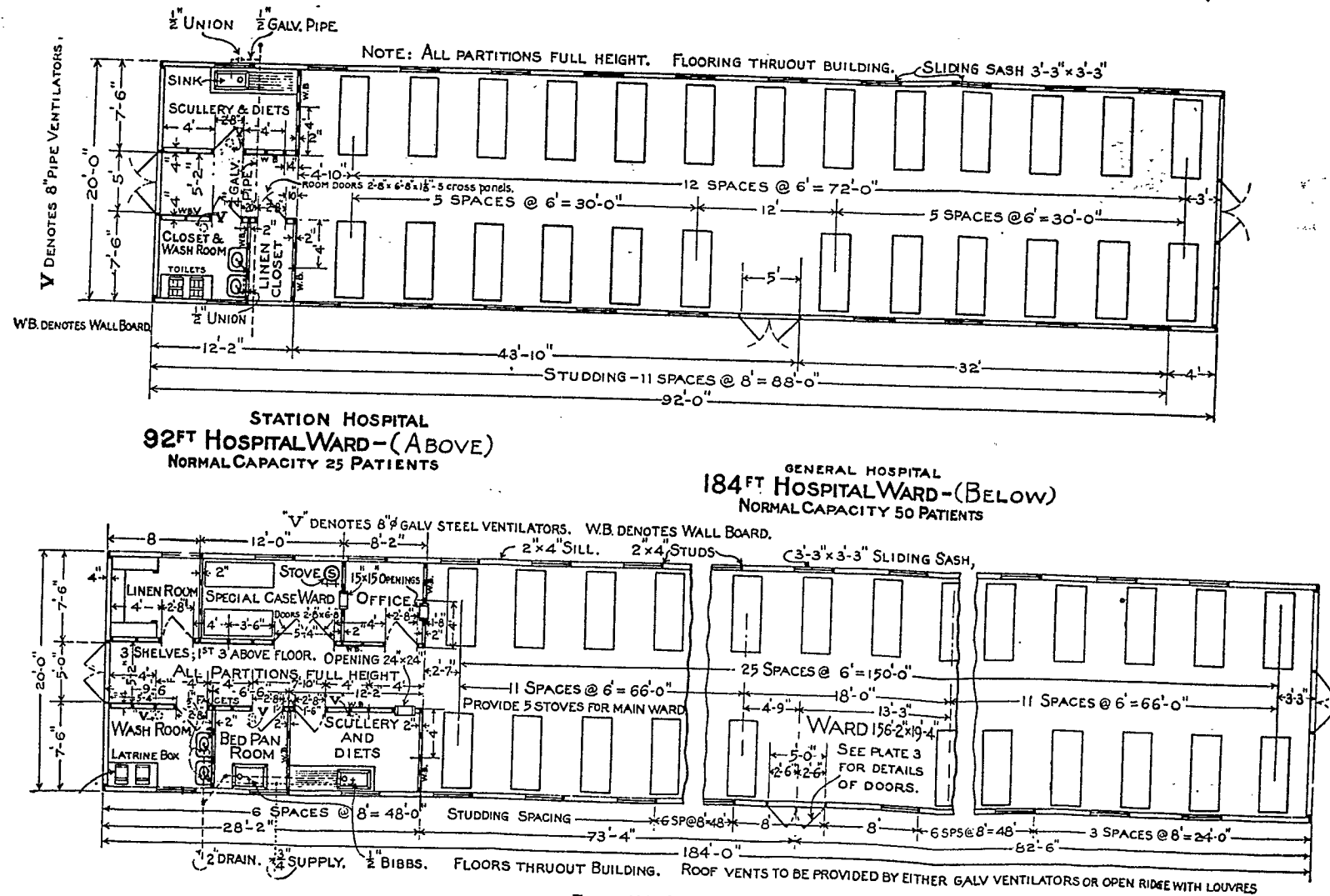


Figure 115.—Hospital wards.

TABLE LI.—*Bill of materials for standard hospital ward—Continued*  
WOOD SHEATHED AND FELT COVERED

92-foot ward building, type 1, normal capacity, 25 patients				184-foot ward building, type 2, normal capacity, 50 patients				Items
Number of pieces	Size	Length	Feet, board measure	Number of pieces	Size	Length	Feet, board measure	
19 rolls	32 inches wide.	770 linear feet.	2,048 square feet.	39 rolls	32 inches wide.	1,580 linear feet.	4,212 square feet.	1-ply "prepared roofing," sides, ends, and doors. Lath for sides, ends, and doors, and 12 ounces 2-penny nails per bundle.
5 bundles	$\frac{1}{4}$ by $1\frac{1}{2}$ inches.	4 feet.		8 bundles	$\frac{1}{4}$ by $1\frac{1}{2}$ inches.	4 feet.		
5 rolls	32 inches wide.	203 linear feet.	540 square feet.	9 rolls	32 inches wide.	365 linear feet.	972 square feet.	2-ply "prepared roofing," with nails, tin caps, and cement, for louver.
54	$\frac{7}{8}$ by 6 inches.	16 feet	432	112	$\frac{7}{8}$ by 6 inches.	16 feet	896	Sheathing for louver roof.
22	2 by 4 inches.	10 feet	147	46	2 by 4 inches.	10 feet	307	Framing for louver.
30	$\frac{7}{8}$ by 3 inches.	12 feet	90	62	$\frac{7}{8}$ by 3 inches.	12 feet	186	Baffle boards and small brace blocks for louver.
1	8 inches wide.	180 linear feet.	189 square feet.	1	8 inches wide.	356 linear feet.	287 square feet.	Screen wire, black, and 8 ounces of $\frac{1}{4}$ -inch blind staples per 100 linear feet.

316

■ 191. WATER.—Pipe distribution of water is provided for semipermanent camps and hospitals whenever possible. This subject is discussed in chapter 7, in which section V covers pipe distribution, and section VI covers water requirements of men, animals, and engines. A general figure of 30 gallons per man and 10 gallons per animal per day is reasonable for estimates for semipermanent camps.

■ 192. ELECTRIC POWER.—Electricity is provided to a limited extent in semipermanent camps and hospitals. The subject is discussed in chapter 8, section II. For camp estimates, allow four 25-watt lights per barrack, 20 by 100 feet, and one 40-watt light per officer.

■ 193. HEATING.—All heating of wartime buildings and tents should be by stoves. Coal, wood, or gasoline may be used as a fuel, depending on which is most plentiful.

■ 194. ERECTION OF BUILDINGS.—*a. Organization.*—The following table shows a suitable organization for erection of the standard building. In a large project time generally is gained by having each detail of men work at the same operation exclusively, and carrying out the successive steps in the nature of a drill.

TABLE LII.—*Personnel for erection of standard building, 20 by 100 feet*

Operation	Number of men
1. Piers and sills.....	24
2. Assembly of side frames.....	36
3. Erection of side frames.....	All available
4. Assembly of side frames.....	9 at each end.
5. Placing rafters and knee braces.....	36
6. Applying sheathings.....	36
7. Applying roof boards.....	36
8. Applying composition roofing paper.....	36
9. Hanging doors and widows.....	24

*b. Man-hours.*—The following table gives approximate number of man-hours required for construction of various structures. These figures represent the results that may be expected of average troop labor under average conditions.

TABLE LIII.—Approximate man-hours for construction under average conditions

Type of construction	Man-hours
Standard barracks, 20 by 100 feet (no floor).....	270
Type A floor.....	360
Type B floor.....	590
92-foot hospital ward:	
Type A floor.....	335
Type B floor.....	550
184-foot hospital ward:	
Type A floor.....	670
Type B floor.....	1,090
Mess hall, 20 feet by 100 feet (no floor).....	330
Latrine, 12-seat.....	50
Bathhouse:	
Concrete floor.....	225
Wood and corrugated-iron floors.....	200
Open-sided storage shed (216 feet long).....	300
60 bunks (2-man).....	200
Camp, triangular infantry division.....	165,000
Station hospital, buildings only (250-bed) (fig. 114).....	10,000

TABLE LIV.—Unit requirements for theater of operations facilities

Facility	Size of typical unit	Number men per typical unit	Basic ratio
1. Barrack.....	20 by 100 feet.....	50 (single bunks) 100 (double tier bunks). (in emergency)	40 square feet per man.
2. Hospital.....	20 by 92 feet.....	25.....	20 square feet per man. 90 square feet per man.
(all facilities).....	20 by 184 feet.....	50.....	
3. Latrine.....	20 by 8 feet (12 seats).....	240 to 480.....	1 seat per 20 to 40 men.
4. Bathhouse.....	20 by 24 feet.....	240.....	1 bathhouse per battalion area.
5. Lavatory.....	20 by 12 feet.....	100 to 200.....	1 lavatory per company.

## SECTION III

## SUPPLY FACILITIES

■ 195. PORTS.—*a. Supply debarkation.*—Wartime port facilities ordinarily are provided by expansion or adaptation of existing facilities. Experience shows that about 1.25 tons per day per linear foot of dock frontage can be unloaded. Assuming supply shipments at the rate of 40 pounds per man per day, 16,000 linear feet would be required for a force of

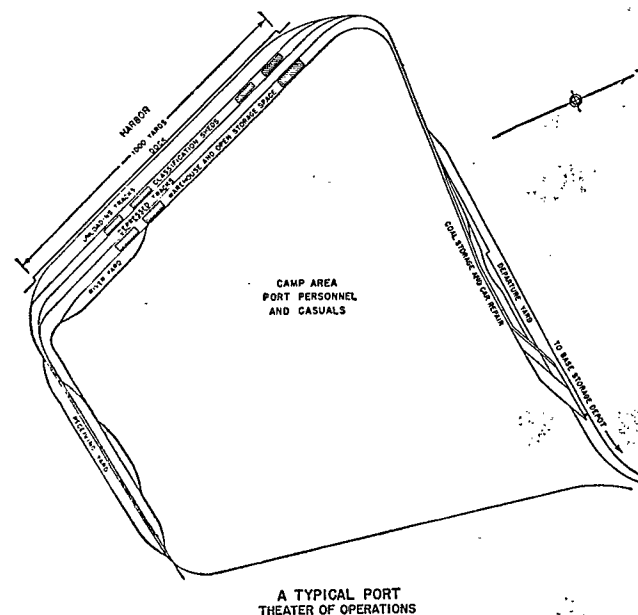


FIGURE 116.—Schematic plan of a typical port layout

1,000,000 men. Several additional docks should be provided for unloading ammunition, each about 150 feet long, or sufficient to receive two lighters at one time. Lighters and barges also can be used for handling cargoes and unloading troops. Figure 116 is a schematic plan showing track layout of a

typical port. The railroad facilities required are similar to those in a storage depot (fig. 117). When conditions permit, the wharves and the base storage depot should be located in the same area, allowing one set of receiving and departure yards, coal storage, and car-repair facilities for the entire installation. For a port alone, with no adjacent depot, approximately 70 miles of track are required for a dockage of 8,000 feet front. The entire wharf and storage space should be accessible to trucks. Initially, cargoes are unloaded using ship's tackle. Cargo-handling machines may be installed later if the amount of tonnage handled is large.

*b. Troop debarkation.*—In addition to the facilities shown in figure 116, a port for debarking and entraining troops should include a troop entraining yard and a camp nearby with quartermaster warehouse, messing, bathing, and hospital facilities. For debarking and entraining 10,000 troops per day, the total trackage will amount to about 35 miles, and the camp should provide for 20,000 men, with expansion possible to 40,000-man capacity.

■ 196. DEPOTS.—Depots are supply installations for the reception, storage, issue, and shipment of supplies. General depots serve two or more supply services and arm or service depots a single arm or service. The essential facilities in the two types of depots are the same.

*a. General depots.*—(1) Figure 117 shows a typical layout for a general storage depot. The warehouse area is laid out in sections. Each section has a ladder track on each side connected by house tracks about 1,700 feet long (forming the rungs of the ladder). Thus three 500-foot warehouses can be served by each house track. The house tracks are 150 feet apart, allowing space for open storage on the opposite side of the track from the buildings.

(2) Initially supply services should be assigned locations each with room for expansion and separated by distances of 1 to 5 miles for purposes of dispersion. Construction in all locations should proceed simultaneously. Storehouses should be distributed to permit storage of each type of commodity on its individual track and to permit a commodity being loaded on one track while being received on another. Existing roads

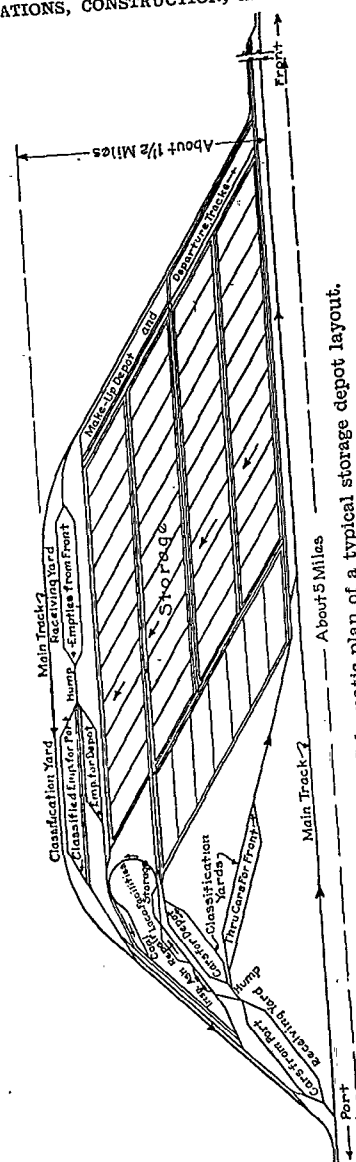


FIGURE 117.—Schematic plan of a typical storage depot layout.



should be blocked only when necessary. Warehouses near roads are needed by each supply service to permit truck shipments.

(3) Buildings are spaced sufficiently to prevent fire from spreading from one to another. Groups of warehouses are separated by open storage spaces. Hay and dynamite are stored on isolated sidings. No water pipe and fire hydrant system is provided because of prohibitive cost.

(4) Figure 118 shows a suitable type of wooden warehouse. It is 20 feet wide, and can be extended to any desired length. Sides are necessary only on buildings for storage of perishable supplies. In place of windows, the sides may be carried to within 12 or 18 inches of the roof, leaving a continuous opening protected by the eaves. Doors are not essential; canvas curtains are sufficient. In general, floors are not necessary. To preserve perishable supplies from water, dunnage consisting of wood poles overlaid with rough plank may be used. Floors at car level are not constructed, because of scarcity of time, labor, and materials.

(5) Cold-storage plants for meat preservation may be required. Unless type plans are provided, their design should be based on civil practice, modified to meet military exigencies.

(6) Bakeries and coffee-roasting plants may be necessary. The former require an ample water supply nearby.

(7) A special warehouse is desirable for use in making up less than carload shipments from the various departments. The warehouse should be near the departure yard.

(8) Camps for depot operating troops should be located on existing roads, and so distributed that personnel belonging to each supply service can easily walk to work.

(9) A warehouse should be provided for local issues to the camp for the depot operating troops. It is essential to separate the supply functions of the camp and the depot.

(10) Necessary office space for each supply service should be provided in standard buildings adjacent to the respective storage areas.

(11) *Water supply.*—In addition to water for personnel, there must be water for locomotives and possibly ice plants



and bakeries. A large depot may use about 500,000 gallons per day.

(12) *Electricity.*—Experience has shown that in the intermediate and base depots very little night work is necessary, and it is unnecessary to install electric lights in the warehouses. Portable illuminating sets may be used in emergencies.

(13) *Railway facilities.*—A general storage depot requires so much railway operation in connection with the depot that engine terminal facilities near the depot are essential. They are shown in figure 117. In the storage area, the cars are pushed into the storage track from the ladder on one side and taken out at the other, thus always maintaining a flow in one direction.

b. *Ammunition depots.*—Ammunition, other than small arms, is stored in Ordnance Department depots. To localize the effect of accidental explosions, as well as to minimize the damage from aerial bombing, warehouses and open storage areas are separated from each other and from other facilities by 200 to 800 feet. Limited railway yard facilities are needed for making up ammunition trains. Administration, traffic, and living facilities common to all types of depots are also necessary.

c. *Motor transport depots.*—Quartermaster Corps depots include those for reserve pools of motor vehicles. Repair facilities and open storage parks are needed. Standard buildings, storage sheds, and warehouses are used for repair and for spare parts storage. Storage parks are graded and drained, but not surfaced. A camp for personnel is provided.

#### SECTION IV

#### AIR CORPS FACILITIES

■ 197. *GENERAL.*—The Air Corps may require special construction at airdromes, depots, and training centers. An airdrome is an establishment including a landing field and facilities for the maintenance, administration, supply, and repair of the unit. Air Corps depots are basically similar to general depots. A training center is an airdrome used primarily for the training of new personnel.